REMARKS

Claim 12 was previously cancelled. The Office Action incorrectly indicates that claims 1-22 are pending and rejected, but only claims 1-11 and 13-22 are currently pending.

Claims 1 and 11 have been amended herein to more particularly point out and distinctly claim the subject matter for which patent protection is sought.

The following table identifies each amendment of independent claims 1 and 11 and passages of the specification, at least, that provide support for these amendments:

Claim	Amendment	Support
1.	In "controlling" step, insert "of spatially sparse stimuli" after "each sequence".	Amended for antecedency with preceding "simultaneously presenting" step, which refers to "respective sequence of spatially sparse stimuli".
1.	In "controlling" step, insert "rendering the stimuli spatially sparse stimuli" after "non-null stimuli".	See paragraph [0025] "... In this way the total stimulus is rendered spatially sparse." See paragraph [0026] "... This arrangement also reduces the number of directly adjacent neighbouring regions that display a non-null stimulus at any time step in the sequence of stimuli and so the stimulus is rendered spatially sparse." Also see paragraphs [0027], [0066], [0071], [0072], and [0087].
1.	In "determining" step, insert "simultaneous" before "responses".	Amended for antecedency with preceding "measuring" step, which refers to "one or more simultaneous responses".
11.	In "processor adapted to: ... control ..." feature, insert "of spatially sparse stimuli" after "each sequence".	Amended for antecedency with preceding "stimulator" feature, which refers to "respective sequence of spatially sparse stimuli".

11.	In "processor adapted to: ... control ..." feature, insert "rendering the stimuli spatially sparse stimuli" after "non-null stimuli".	See paragraph [0025] "... In this way the total stimulus is rendered spatially sparse." See paragraph [0026] "... This arrangement also reduces the number of directly adjacent neighbouring regions that display a non-null stimulus at any time step in the sequence of stimuli and so the stimulus is rendered spatially sparse." Also see paragraphs [0027], [0066], [0071], [0072], and [0087].
11.	In "processor adapted to: ... determine ..." feature, insert "simultaneous" before "responses".	Amended for antecedency with preceding "monitor" features, which refers to "one or more simultaneous responses".

The claims have been rejected as follows:

A. Claims 1-5, 7-11, 13-17, and 19-22 (*i.e.*, all but claims 6 and 18) are rejected as being obvious under 35 USC §103(a) over Maddess *et al.* (US 2003/0163060) in view of Livingstone *et al.* (US 5,474,081) (paragraphs 3 to 14 of the Office Action).

B. Claims 6 and 18 are rejected as being obvious under 35 USC §103(a) over Maddess *et al.* (US 2003/0163060) in view of Livingstone *et al.* (US 5,474,081) and further in view of Thornton (US 6,743,183) (paragraphs 15 and 16 of the Office Action).

Applicant respectfully traverses these rejections.

A. CLAIMS 1-5, 7-11, 13-17 AND 19-22

Applicant respectfully asserts that no combination of Maddess *et al.* and Livingstone *et al.* renders the invention of claims 1-5, 7-11, 13-17 and 19-22 obvious.

Maddess *et al.*

Applicant maintains his earlier comments made about Maddess *et al.*

Specifically, Maddess *et al.* describes ensembles of multiple independent stimuli that are presented to subjects. The independence of the stimuli in the ensemble derives from pseudorandom temporal sequences that determine the appearance or non-appearance of each of the stimuli in the ensemble. Thus, for an ensemble of N stimuli, there are N different temporal modulation sequences. This arrangement permits responses to each of the N stimuli to be measured.

Further, Maddess *et al.* teaches interleaving aperiodic null stimuli, and using mean presentation rates between 0.25 and 25 presentations per second, and more particularly 1 and 6 presentations per second, so that signal-to-noise ratios are enhanced compared to not inserting such breaks. Such stimuli are said to be *temporally sparse*. These mean presentation rates derive from the random appearance rates of the stimuli and do not imply a periodic rate determined by a fixed interval.

Livingstone *et al.*

The Office Action asserts that Livingston *et al.* (US5474081) teaches spatially sparse stimuli, relying on the passage at col. 7, line 57 to col. 8, line 13:

> *In practice, each checkerboard pattern is about 24×18.5 centimeters and consists of 36 rectangles, each 4×3 centimeters, presented at a*

> *viewing distance of 60 centimeters. Spatial frequency is thus about 0.16 cycle per degree vertically and 0.12 cycle per degree horizontally. For each checkerboard pattern in the series of patterns displayed by apparatus 21 of FIG. 1, the checkerboard pattern is displayed for about 1 second and is then* ***<u>reversed in a counterphase square wave temporal pattern at 0.5 Hz</u>*** *(1 contrast reversal per second). Other frequencies for contrast reversing each of the checkerboard patterns are also suitable, for example in the range of about 0.5 Hz through 15 Hz. After alternating between a checkerboard pattern and its corresponding contrast reversal for a total of about 2 seconds, the next checkerboard pattern in the series is displayed in a similar fashion. That succeeding checkerboard pattern is of a different level or degree of contrast than the first displayed checkerboard pattern. Preferably, a series of checkerboard patterns is presented 32 times, each pattern within the series and it's [sic] contrast reversal being displayed for about 1 second or less each. Thus, the rate at which the checkerboard patterns having different respective degrees of contrast in the series are displayed is preferably between about 30 patterns per minute and hundreds of patterns per minute. (Emphasis added)*

The stimuli described in this passage of Livingston *et al.*, and indeed everywhere in Livingston *et al.*, are not spatially sparse stimuli. The two key features of the stimuli of Livingston *et al.* are:

- their "checkerboard" nature (see col. 2, lines 40-42 of Livingston *et al.*), and
- they should have a temporal modulation that is <u>contrast reversing</u>, or <u>reversing in phase</u> at a particular rate.

That the stimuli of Livingston *et al.* are checkerboards in the normal English sense is clear from Figs. 2C and 3A of Livingston *et al.* This is restated at other points in Livingston *et al.*, most notably at col. 5, lines 57-64:

> *The graphics routine next paints the screen a first color or brightness (referred to as the background color). Then according to calculated dimensions of each checkerboard square, the routine fills every other square of that size with a contrasting color (referred to as foreground color) along a row. The routine repeats the square filling*

> *step along other rows in a staggered manner to produce the checkerboard pattern.*

The meaning of contrast reversal in Livingston *et al.* is made plain at col. 2, lines 48-51:

> *... the checkerboard pattern is alternately displayed with a corresponding contrast reversed pattern. That is, the light and dark areas of the checkerboard pattern are swapped to form the corresponding contrast reverse pattern.*

The exchange of contrast between the alternating regions of the checkerboard can be understood as a square-wave modulation of the checkerboard contrast, as stated at col. 7, lines 64-65, shown above in bold and underlined (*"reversed in a counterphase square wave temporal pattern at 0.5 Hz"*).

The checkerboard nature of the preferred stimuli is made most explicit by the *CHECKERBOARD GRAPHICS ROUTINE* at the top of col. 6 of Livingston *et al.* Here, it is clear that the foreground is set to 0 ("Fcolor = 0"), and then the checkerboard coloring is controlled by two nested loops controlled by i and j in the routine at col. 6, line. 12-30. The variable i goes from 0 to 9 and is the counter of the rows ("*for each of 10 rows*"), while j is the counter of columns ("*for each of 15 columns in a given row*"). The coloring of a given check in the routine is given by the formula:

$$\text{color} = [(i+j)\bmod 2] + \text{Fcolor},$$

where mod 2 is standard mathematical nomenclature for modulus to the base 2. Hence, at the start i=j=0 and so the color is 0+0 = 0, on the next step the column counters is incremented to 1 and the color = 1+0 = 1, and the colors continue to alternate 0, 1, 0, 1,... Notice that at the start of the second row i=1 and j=0 and so the first check has color 1+0

=1, the opposite of the check above it in the first row. If we take 0 to mean dark and 1 to mean light, then the graphics routine of Livingston *et al.* draws out the checkerboard as depicted in Fig. 3A, except with 10 rows and 15 columns.

Notice that, once the two loops of the graphics routine of Livingston *et al.* are completed and the checkerboard is drawn, the graphics routine of Livingston *et al.* executes the "flicker()" routine, described in the comment as "*present for desired time and contrast reverse*". Contrast reversal refers to the process "the light and dark areas of the checkerboard pattern are swapped to form the corresponding contrast reverse pattern" mentioned already. That is, the checkerboard exchanges its checks going from the state in Fig. 3A to that in Fig. 2C and back again for some period of time, except in this example the checkerboard drawn by the program has 10 rows and 15 columns. ***In either condition, normal or reversed, these stimuli are clearly not spatially sparse because any check type always has spatial adjacent neighbours of the same type.*** Also some stimuli are always on and so they are clearly not temporally sparse either.

Moreover, not only are Maddess *et al.* and Livingstone *et al.* individually inadequate as detailed above, but contrary to the assertions in paragraphs 17 to 20 of the Office Action, in view of those inadequacies, Maddess *et al.* and Livingstone *et al.* also cannot be properly combined to render the claimed invention obvious.

Claimed Invention

The Applicant asserts that spatially sparse stimuli as recited in independent claim 1 is not taught or suggested by Livingston et al. The instant patent application distinguishes between things that do not evoke a response, such as a neutral grey background, labelling these as "null-stimuli". Things that would evoke a response are therefore called "non-null stimuli", as recited in claim 1. Spatially sparse stimuli are those that when presented have spatially neighbouring regions occupied mainly or completely by null stimuli. This means that a given non-null stimulus tends not to have neighbouring stimuli that are also non-null stimuli. See for example paragraphs [0008] and [0010] of the instant patent application:

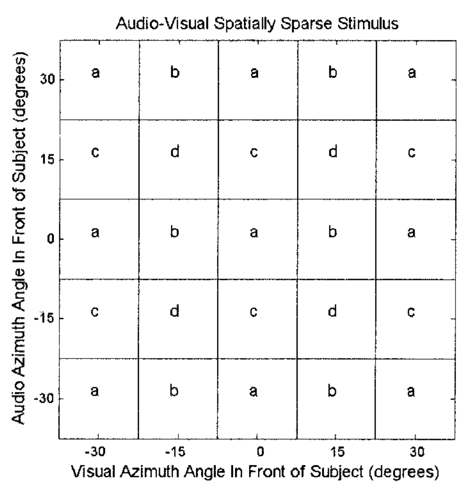
> [0008] ... *controlling the variation of each sequence so that neighbouring parts of the sensory system are less likely to receive simultaneous non-null stimuli ...*
>
> [0010] ... *Preferably the probability of neighbouring parts in the sensory system having simultaneous non-null stimuli is zero. ...*

In comparison, the stimuli of Livingston *et al.* are not spatially sparse. For example, as shown, every white square in a checkerboard has 4 white neighbours. That is, every bright non-null stimulus always has 4 adjacent bright non-null stimuli. Clearly, there is no attempt to minimise the number of neighbouring co-presented stimuli in Livingston *et al.* Instead, every stimulus element is required to have a large number of neighbouring stimulus elements present at the same time. That is, Livingston *et al.* teaches the opposite of the claimed invention.

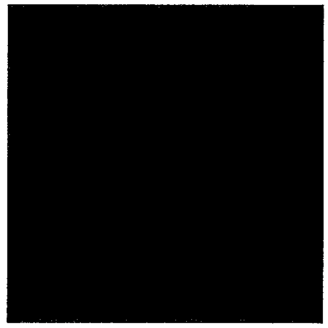
The instant patent specification has a flowchart in Fig. 5 illustrating a program for the production of spatially sparse stimuli. This is to be operated upon a system of

neighbouring regions, as depicted in Fig. 3 Type II or Figs. 10 to 13 and described at paragraphs [0052], [0064], and [0066], which like Fig. 5 have 4 families of regions A to D. Fig. 11 of the instant patent application is superficially similar to Figs. 2C and 3A of Livingston *et al.*, so for purposes of explaining the method of Fig. 5 is performed on Fig. 11 of the instant application to see how spatially sparse stimuli differ from the checkerboards of Livingston et al. To aid understanding, the null condition is dark, and the non-null condition is light.

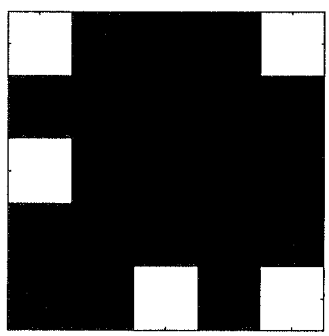
Fig. 11 of the instant application is reproduced below:



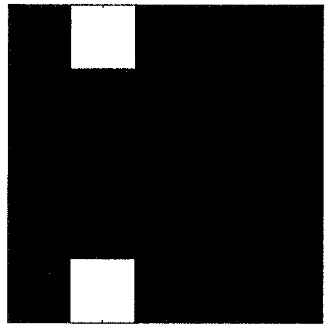
The program is then stepped through. In the start condition, “set all stimulus regions are set to the null condition”:



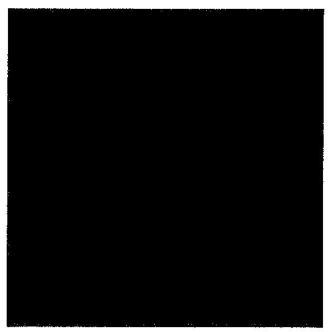
Select regions of family **a**, then within that selected group "select with probability 0.5 which regions will present non-null stimuli." "This selection makes the ensemble of stimuli spatially sparse". White non-null stimuli are selected and presented such that "the stimulus persists for only a short duration":



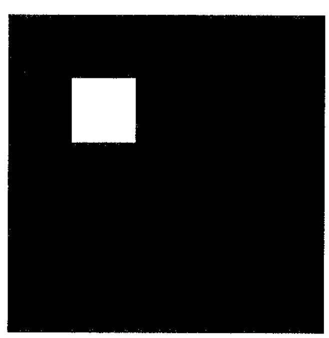
Thus, all stimuli shortly return to the null condition to render all regions temporally sparse. If the stimuli are to continue select family **b** and randomly assign some to be active with probability 0.5 for a short time:



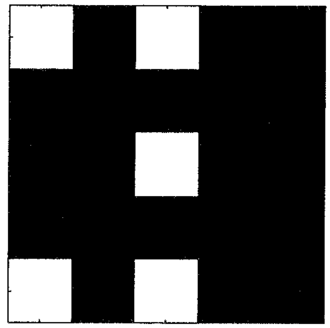
Again after waiting with all element set to null, select the members of family **c** and set them bright with p = 0.5:



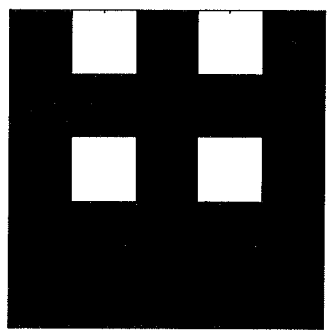
In this case, due to chance, no member of the c group was active. After the waiting period, select from family **d** and set some of them with p = 0.5:



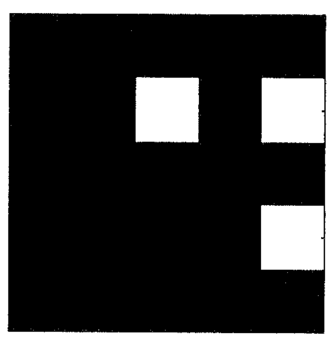
Repeat the sequence now returning to family **a** after the wait time:



and again with family **b.**



and **c:**



and so on. See also the text in [0066] which describes Fig. 5.

Importantly, clearly no active element ever has an adjacent spatial neighbour that is also active. Indeed, sometimes there are no active elements. That is the definition of spatially sparse. This situation is completely different to Livingston *et al.* where on every presentation every active stimulus region is obliged to have active adjacent regions in order that the ensemble of stimuli is a chequer board. In this sense, Livingston *et al.* teaches the exact opposite of the instant patent application.

Checkerboards in Instant Application

A possibly confusing feature of the instant application may be that Fig. 2a shows a checkerboard pattern, the time course of which indicates random switching between two polarities indicated as state 1 or -1 as a function of "Time (s)" [0063]. As just shown above a feature of sparse stimuli is that that each stimulus is only present briefly between aperiodic intervals showing a null-stimulus.

> *[0065] ... For the null stimuli a given region was a featureless grey at the mean luminance, which is represented by level 0 in FIG. 2b,c and in this figure by regions marked by a stippling of small dots.*

Thus, clearly the sequence in Fig. 2a cannot be that of a sparse stimulus, as indicated in [0098]:

> *... We did not use these temporally dense binary stimuli, but such stimuli are in common use, and so they are presented here for purposes of comparison.*

By contrast the stimuli of Figs. 2b and 2c are temporally sparse, having long aperiodic periods of null-stimuli, and examples of mean responses to the stimulus of Fig. 2c are

given in Fig. 6. Paragraph [0065] explains that the intention is that in this particular example each subregion is drawn as in the example above except that each non-null stimulus is not a bright square but is instead a checker board. Thus in the sequence above each bright square would be replaced by a checkerboard. Thus, just as for the bright squares above, the presented checkerboards are never presented with an adjacent checker board. **Hence, the ensemble of checkerboards is spatially sparse.** This is explained in detail in paragraphs [0101] and [0102]. As described in paragraph [0069], Fig. 4 gives an example of one video frame of a stimulus ensemble that is "*only poorly spatially sparse*" because every checkerboard is presented with at least one other adjacent checkerboard. **Livingstone *et al.* for example would teach that some of these cases of pairs of checkerboards, where the phases of the checks is the same in each pair would be considered preferred stimuli, whereas here any of these examples is deprecated as non-optimal.**

Section [0069] explains Fig. 8 which is "is an illustration of the advantage of spatially sparse stimuli over purely temporally sparse stimuli". Fig. 8 compares the signal to noise ratio (SNR) obtained from two reference stimuli that are only temporally sparse, with the SNR for stimuli that are identically temporally sparse, but which are also spatially sparse. Spatial sparseness is created using the method of Fig. 5 and the families of regions of the Type I and II methods of Fig. 3. Fig. 4 is example of one video frame of these reference temporally (but not spatially sparse) stimuli. In this example, "The spatial

relationships between the neighbours of the reference stimuli was randomised; hence there was a reasonable chance of two neighbours simultaneously displaying a non-null stimulus. FIG. 4 gives an example of a possible frame of this stimulus ensemble. Thus, the reference stimuli were only poorly spatially sparse." That is, by not controlling the relationship between spatial neighbours there was a good chance of a video frame like that shown in Fig. 4 where some stimulus regions were presented with adjacent regions (*i.e.*, the stimulus ensemble is frequently not spatially sparse).

One versus many responses

Livingstone *et al.* teaches that optimally the apparatus records the voltage responses of the subject's brain and subjects that record to a Fourier transform (see col. 4, line 20-36) to extract (see col. 4, lines 60 to 64) "the power of the Fourier spectrum at the same frequency as the contrast reversal rate (two times the stimulus cycle rate) of the visual stimulus (displayed pattern)."

Thus, the single, not spatially sparse, checkerboard stimulus is contrast reversed at a given rate and the electrical response of the brain is monitored for a response to the contrast reversal. In the case of the claimed invention, the ensemble of stimuli are presented, with each region of the ensemble modulated by a difference pseudo-random sequence. This permits responses to each stimulus region to be estimated. The method of spatial sparseness means that the SNR obtained for each stimulus region is optimised, and better even than a temporally sparse method in which there is no control over when adjacent regions can appear.

Thus, the claimed invention is a method for optimally presented an ensemble of concurrently presented stimuli whereas Livingstone *et al.* is a method for presenting and measuring responses from one stimulus at a time, each of those stimuli not being spatially sparse.

Thus, independent method claim 1 is in condition for allowance, since the cited references do not disclose or teach the claimed invention. Independent apparatus claim 11 directly tracks on independent method claim 1 and therefore is in condition for allowance for the same reasons.

Dependent claims 2-5 and 7-10 being dependent claims of an allowable base claim 1 are themselves in condition for allowance. Likewise, dependent claims 13-17 and 19-22 being dependent claims of an allowable base claim 11 are themselves in condition for allowance.

B. CLAIMS 6 AND 18

Claims 6 and 18 stand rejected as being obvious under 35 USC §103(a) over Maddess *et al.* (US 2003/0163060) in view of Livingstone *et al.* (US 5,474,081) and further in view of Thornton (US 6,743,183).

Applicants respectfully submit that Thornton does not overcome the shortcomings of Maddess *et al.* and Livingstone *et al.*, as set forth above. Accordingly, dependent claims 6 and 18 being dependent claims of an allowable base claims 1 and 11, respectively, are themselves in condition for allowance.

CONCLUSION

For at least the above stated reasons, Applicant respectfully asserts that all of pending claims 1-11 and 13-22 are in condition for allowance as presented herein. Early notification to that effect is respectfully requested.

Respectfully submitted,

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